1127-122 Quantitative Assessment of Ventricular Septal Defect Shunt Flow by Three-dimensional Reconstruction of Color Doppler Imaged Vena Contracta and Flow Convergence Region

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An accurate and noninvasive method for quantifying flow across a ventricular septal defect (VSD) has yet to be implemented for routine clinical use. The aim of our study was to examine the usefulness of 3 dimensional (3D) reconstruction of color Doppler imaged vena contracta (VC) and flow convergence region (FCR) as means of accurately estimating severity of VSD. We performed 3D reconstruction of color Doppler imaged VC and FCR with a ultrasound system interfaced with a Tomtec computer for 180° rotational transthoracic scan acquisitions in 19 children with single VSD. Areas of VC were measured using a slice perpendicular to the VSD shunt jet just distal to the left septal surface. Shunt flow rate calculated by (1) 2D method: aliasing velocity v and aliasing radius r by $2\pi r^2 v$, (2) 3D method: multiplying surface area of 3D reconstructed FCR by v. These Results were compared with shunt flow rate determined at cardiac catheterization as reference method.

Result: The variable asymmetric geometry of the color Doppler imaged VC and FCR could be reconstructed and visualized in 3D in patients with VSD. There was good relationship between shunt flow rate determined by cardiac catheterization and VC area ($r = 0.97$, $p = 0.0001$). VC area increased from 0.12 to 2.0 cm^2 as shunt flow rate increased (0.18 to 3.6 l/min). The VC geometry imaged using 3D reconstruction was quite difficult to appreciate in 2D color Doppler images, which are perpendicular to VC flow. Good correlation between shunt flow rate calculated by 2D or 3D FCR methods and determined by cardiac catheterization were demonstrated ($r = 0.94$, 0.97, respectively). However, 2D method substantially underestimated (mean difference −0.59 ± 0.50) actual shunt flow rate. The 3D estimation also showed a tendency for underestimation of the corresponding reference results (mean difference −0.25 ± 0.30). This first study of 3D flow quantification in children with VSD suggested that 3D reconstruction techniques for flow enhanced quantification of shunt flow rate of VSD using VC and FCR techniques. Thus, 3D reconstruction of VC and FCR may aid quantitation of VSD flow rate.

1127-123 Lack of Dynamic Change in Effective Aortic Regurgitant Orifice Area Measured by Direct Flow Convergence Surface Area From 3D Flow Images: A Chronic Animal Study

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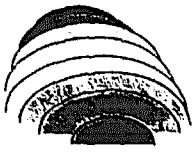
Using direct measurement of the three-dimensionally reconstructed flow convergence (FC) surface areas computed without any geometrical assumption, we investigated temporal change in effective orifice area (EOA) for sheep with chronic aortic regurgitation (AR). In 6 sheep with surgically induced chronic AR, 20 hemodynamically different states were studied. Reference instantaneous regurgitant flow rates were obtained by aortic and pulmonary electromagnetic (EM) flow meters. Instantaneous EOA was derived from dividing EM flow rates by corresponding CW velocities. After 3D reconstruction of color Doppler dataset, 4 to 7 direct measurements of 3D FC surface areas for each hemodynamic condition during diastole were performed by sectioning the 3D FC dataset. Using the continuity concept, instantaneous EOA was calculated as FC Area x aliasing velocity/CW instantaneous velocity. Mean EOA by EM ranged 0.04 cm^2 to 0.31 cm^2.



Measurement of a 3D FC surface area

Despite a variety of FC surface shapes geometry found on 3D reconstructions, there were no abrupt changes in FC EOAs during diastole once the orifice had opened fully. Also, there was a good agreement between 3D and EM derived mean EOA values ($r = 0.95$, mean difference = 0.02 ± 0.015 cm^2).

1127-124 Facilitation of Three-dimensional Echocardiographic Color Doppler Jet Volume Calculations

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Background: The determination of color Doppler jet volume by three-dimensional echocardiography (3DE) may allow more accurate quantification of regurgitant flow. Calculation of jet volume using the most widely available 3DE system (TomTec Imaging Systems) necessitates a rather time-consuming off-line segmentation process which involves manual tracing of the jet border in multiple orthogonal slices down its length.

Methods: This study was designed to assess whether the segmentation process could be facilitated using the 3D system's existing thresholding software to trace the jet border. We studied a series of regurgitant jets generated by steady flow rates (0.2–2.5 l/min) through circular orifices (diameters 2, 6 and 10 mm) mounted in a purpose-built flow model. Imaging was performed in an orthogonal axis to the orifice plane using an ATL Apogee 800 imaging system. Color Doppler machine settings were held constant throughout. Multiple 2D images were obtained by 180 degree rotational acquisition and transferred as black and white video composite data to a TomTec Echoscan workstation for generation of a 3D dataset. The volume of each reconstructed jet was then calculated using the standard segmentation procedure (V_1) [mean slice thickness 5.0 mm] and the new threshold technique (V_2).

Results: Correlation between flow rate and 3D jet volume was good for each orifice diameter (overall $r = 0.91$). The mean difference between V_1 and V_2 was small (−2.31 ml, SD 1.51 ml). Calculation times were significantly shorter for the threshold method (2.6 v 5.0 mins, $p < 0.001$). This improvement in off-line calculation time without loss of accuracy may enhance the clinical application of 3D flow quantification.

1128 Value of Stress Echocardiography in Left Ventricular Dysfunction

Tuesday, March 31, 1998, Noon–2:00 p.m.
Georgia World Congress Center, West Exhibit Hall Level
Presentation Hour: Noon–1:00 p.m.

1128-137 Does Exercise Echocardiography Have Prognostic Value in Patients With Left Ventricular Dysfunction?

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Background: Stress echocardiographic assessment of ischemia may be more difficult in patients with left ventricular dysfunction. We examined the incremental prognostic value of exercise echocardiography (Ex Echo) in pts with ejection fraction (EF) < 40%.

Methods: From our database of 6512 patients who had treadmill Ex Echo from 1990 through 1995, 259 (4%) had EF < 40%. Follow-up was complete in 248 patients (96%).

Results: The patients' mean age was 66 ± 11 years, 217 (84%) were male, 182 (74%) had previous myocardial infarction (MI), 110 (43%) had hypertension, 39 (15%) had diabetes mellitus, and 61 (24%) were on digoxin. Mean resting EF was 30 ± 5%. Exercise capacity was inadequate in 109 (44%) pts (< 5 Mets for women and < 7 Mets for men). Reasons for stopping exercise included fatigue in 125, dyspnea in 90, angina in 22, and other in 8. The ECG was positive for ischemia in 46 pts. The Ex Echo was positive for ischemia in 126 pts. Mean follow-up was 2.8 ± 1.7 years. Cardiac events included late revascularization (after 3 months) in 24 pts, nonfatal MI in 6 pts, and cardiac death in 11 pts. Multivariate predictors of cardiac events were: ischemia by ECG ($p = 0.0004$; X^2 12.3) percentage of abnormal segments at peak stress ($p = 0.0037$; X^2 8.4), digoxin therapy ($p = 0.017$; X^2 5.6), history of MI ($p = 0.034$; X^2 4.4). Age, sex, resting EF, exercise capacity, and typical angina were not predictive. With an abnormality in 5 of 16 segments, risk of cardiac events increased ~2 fold.

Conclusion: In patients with left ventricular dysfunction, the percentage of segments abnormal at peak stress, which reflects extent of both infarction and ischemia, provided independent prognostic information in addition to clinical (history of MI, digoxin herapy), and exercise testing parameters (ischemia by ECG).

TUESDAY POSTER